Cognitive biases and numerical reasoning and their relationship with problem gambling in skilled and chance-based activities

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ABSTRACT

Gambling can be divided into activities of chance (e.g. gaming machines) or skill (e.g. sports betting). With the rise of sports betting over recent years, treatment services are now facing increasing proportions of people with problems related to sports-betting or other related skill-based activities. However, many existing cognitive therapy approaches to gambling are largely focused on addressing false beliefs about chance and randomness, which may not be translatable to skill-based forms of gambling. Problem gamblers are more likely to endorse a range of gambling-related erroneous beliefs when compared to regular gamblers, which contributes to persistent problem gambling. Previous research has found that higher levels of irrationality are not attributable to low understanding of objective odds or numerical reasoning skill. It is proposed that skill-based betting may be maintained and driven by a wider range of cognitive beliefs relating to skill in gambling. The present study examined gambling-related and skill-related erroneous beliefs and numerical reasoning skills of problem gamblers, non-problem regular gamblers, skill-based gamblers and chance-based gamblers. Results showed that problem gamblers endorse more erroneous and skill-related beliefs than non-problem gamblers, and skill-based gamblers endorse more cognitions relating to skill than chance-based cognitions. Results confirmed previous findings that problem and non-problem gamblers do not differ significantly in their understanding of gambling odds, and that differences in numerical reasoning does not explain cognitive beliefs of skill in skill-based gamblers. Skill-based problem gamblers were most likely to score highest on skill-related cognitions. Implications of this research are discussed in relation to the suitability of existing cognitive therapy approaches for skill-based gamblers.

DECLARATION

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CHAPTER 1: INTRODUCTION

1.1 Gambling in Australia

Problem gambling remains an ongoing and growing social concern in Australia, particularly due to the rising availability and involvement of online gambling and in particular, sport betting. It is estimated that up to 1% of Australian are problem gamblers, and an additional 1.4 to 2.1% are classified as “at risk” (Productivity Comission, 2010). The culture of gambling is ever changing due to the increasing ease of access to different types of physical and online gambling platforms, including a multitude of websites and applications accessible at the fingertips of gamblers (Gooding & Tarrier, 2009).

Gambling remains an ongoing social concern in Australia, with total gambling expenditure for 2016-2017 standing at $23.648 billion, (Queensland Government Statistician's Office, 2018). Since 1999, participation rates for all gambling types have decreased, except for sports betting, and race betting has had the smallest decrease, (Gainsbury, 2013). This increase in sports betting is believed to be the result of increased availability, modes and formats of gambling, when compared to traditional land-based options. Sports betting, which is currently the only and fastest growing form of gambling in Australia, experienced a 15.3% increase in expenditure from 2016-2016, (Queensland Government Statistician's Office, 2018) and was the only form of gambling that saw an increase in participation rates (Gainsbury, Russell, Hing, Wood, Lubman, & Blaszczynski, 2013).

Problem gambling is thought to be maintained by an increased dedication of time and money to gambling which can result in adverse consequences to the person, their support network and the wider community, (Dickerson, McMillen, Hallebone, Volberg, & Woolley,

1997; Neal, Delfabbro, & O'Neil, 2005). Numerous theories have been advanced over the last 50 years to explain and understand problem gambling. These include approaches involving operant and classical conditioning, models of addiction originating from the DSM-V, (American Psychiatric Association, 2013), and models explained by neurophysiology (Griffiths & Delfabbro, 2001). However, a focus of this thesis will be upon explanations arising from the field of cognitive psychology, which suggest that problem gambling is maintained by persistent, irrational or erroneous cognitive beliefs held by gamblers.

As will be discussed, cognitive theory suggests that gamblers often do not understand the true nature of gambling. Many over-estimate the amount of skill that can be applied to influence the outcomes or they do not understand the nature of chance and randomness. Such cognitions can lead to an over-estimation of the ability to win at gambling and may lead to people persisting with activities which have an inevitable negative return to the player. These observations have led to the development of cognitive therapies that focus on drawing the gambler's attention to the chance nature of activities and the limited extent to which skill can be applied (Gooding & Tarrier, 2009; Ladouceur et al., 2003; Ladouceur & Sylvain, 1999;Tarrier, 2011; Walker, 1992). Although results from cognitive and behavioural therapy have been promising, a challenge is that gambling activities are not all the same. Instead, they can be divided into two categories: gambling activities of chance (such as electronic gaming machines, pokies, lottery products and casino table games) and activities involving an element of skill (such as sports betting, horse racing and card games). Thus, while it may make sense to draw attention to the lack of skill that might be applied in the chance-based activities, it becomes more complex when activities contain elements of genuine skill.

The aim of the following review is to examine the nature of cognitive approaches to the study of gambling and problem gambling and the issues that arise when trying to study skill as opposed to chance-based activities. Central to this analysis is the extent to which: (a) problem gamblers appear more prone to erroneous beliefs and whether this reflects poorer numerical reasoning or knowledge about gambling; and (b) whether people's preferences for skill as opposed to chance-based gambling may influence how cognitive factors must be approached in problem gambling.

1.2 Cognitive processing and Erroneous Beliefs in Gambling

Problem gamblers find it challenging to cease their gambling habits despite significant financial losses and additional adverse social, psychological and occupational consequences (Ladouceur, 2004; Toneatto et al., 1997; Toplak et al., 2007). A significant body of research demonstrates that cognition and irrational beliefs appear to play an important role in the development and maintenance problem gambling. Cognitive beliefs that may sustain problem gambling include attitudes concerning control, irrational beliefs of control over outcomes, prediction, luck and chance (Toneatto, 1999). It is understood that gamblers may develop a perception that outcomes can be controlled and predicted, rather than determined by chance (Barrault & Varescon, 2013). Literature suggests that these cognitive distortions, also known as erroneous irrational beliefs, are related to, and possibly the cause, of persistent gambling. Studies have typically shown that problem gamblers, when compared to regular non-problem gamblers, are more likely to endorse a wider range of erroneous beliefs, such as beliefs about control or predictability of outcomes, as well as express stronger beliefs in their endorsements (Ladouceur, 2004; Sevigny & Ladouceur, 2004). In particular, previous research (e.g., Toneatto, 1999) suggests that pathological gamblers are more likely to fall victim to several gambling tendencies, including the illusion

of control (Langer, 1975; Thompson, Thomas, & Armstrong, 1998), skill misperceptions, skewed temporal orientation, the gambler's fallacy (Tversky & Kahnaman, 1971), selective memory, superstitious beliefs, availability heuristic (Tversky & Kahneman, 1973; Wagenaar, 1998); biased attributions (Gilovich, 1983; Gilovich & Douglas, 1986) beliefs about the role of luck (Griffiths, 1994) and interpretative biases.

The concepts of cognitive processing and irrational beliefs in pathological gamblers was discussed in depth by Toplak et al. (2007). Toplak et al. (2007) investigated numerous domains of cognitive, motivational and affective control across three sample groups: pathological gamblers, non-pathological gamblers and individuals without gambling problems. They argued that cognitive processing can be separated into two types: analytical processing, which is a slower, methodical, more critical form of processing incoming information, and the autonomous set of systems, which are automatic, fast, implicit and mostly unconscious systems of processing stimuli. These systems can consist of well-learned associations and processing that have developed through patterns of behaviour. The same information is processed by each system; however, in situations where poor decisions are made, what is known as adaptive processing occurs in which the automatic system is overridden by the analytical system. The authors explained that 'system failures' occur in situations where the analytical system fails to identify and correct errors integral to the automatic interpretation of information. Failures of this type are believed to be common in problem gambling. It is thought that these failures result from a range of factors such as the high levels of reinforcement that gambling provides, the impulsivity of gamblers, which is caused by a lack of reflection by the gambler when making decisions, or lastly, learned inappropriate associations or rules from previous gambling practices, such as illusions of control or gambler's fallacy beliefs, which perhaps is due to the occurrence of selective

processing of information. Interference from emotional or motivational processes means the analytical part of the brain has no ability to stop the activation of automatic processes. Therefore, as Toplak et al. (2007) explained, "some mindware [i.e., cognitive tools or strategies] can be the direct cause of irrational actions that… can serve to maintain pathological gambling behaviour." (p. 107). In their research, which comprised 107 gamblers, Toplak et al (2007) found that pathological gamblers were more susceptible to cognitive biases, such as, the gambler's fallacy, probability matching, perceptions of superstitious control, and other similar erroneous strategies.

1.3 Skill and Chance-Based Gambling Activities

Chance-based gambling activities are considered games in which skill or knowledge have no influence on outcomes and where outcomes are random and beyond the control of the gambler. In contrast, in skill-based gambling activities, skill or knowledge can influence the outcome or predicted outcome. In general, while many studies have revealed high levels of erroneous beliefs in gamblers and problem gamblers in particular (e.g., Delfabbro & Winefield, 2000; Griffiths M. , 1995; Walker, 1992a) some studies have shown that it may also be important to examine the type of gambler. Toneatto et al. (1997) found that higher levels of cognitive distortions were associated with games which potentially involved an element of skill, such as sports or cards, than games that involved no skill. This level of irrationality regarding control of the game may be the result of skilled gamblers believing that knowledge can positively impact the outcome of the game. They concluded that these erroneous beliefs not only explain why gamblers persevere even in situations where they are suffering a financial detriment, but also indicate that the added element of skill can generate a greater irrational sense of control over the game, which subsequently may result in gamblers developing financial and negative consequences.

Similar findings were obtained by Myrseth et al. (2010) who found differing levels of illusion of control depending on preference for game type (i.e. skill/chance) and gambling severity (i.e. pathological or non-pathological). Gamblers with a preference for skill games or a combination of skill and chance games, showed higher levels of illusion of control when compared to those who preferred only chance games. This was attributed to Langer's (1975) theory of illusion of control, where gamblers with a preference for skilled games were overconfident in their individual skills, and an illusion of control created an excessive expectation of favoured results. Myrseth et al. (2010) argued that "there is an element of chance in almost any skill situation and vice versa, and the lack of discrimination between controllable and uncontrollable events is attributable to the fact that skill and chance factors are so closely related" (p. 566). This is further supported by Cantinotti et al. (2004), who suggested that information received and relied on during betting only strengthens one's illusion of control and perceived expertise.

However, there is limited existing research that extends beyond the illusion of control and examines the extent to which erroneous beliefs of gamblers with a preference for skill differ to those with a preference for chance games. With the recent rise of online sports betting, further research is needed to better understand the nature of this association and to contribute to the understanding of the effect of emerging sports and skilled betting technologies.

1.4 Perceived or Actual Expertise in Skill-Based Gambling

It has been found that irrational perceptions in gambling are more common than accurate perceptions, irrespective of whether the individual believed the game to be

determined on skill or chance, (Gaboury & Ladouceur, 1989). Previous literature has discussed whether higher levels of cognitive distortions regarding the controllability of outcomes in skill-based gamblers, reflect perceived or actual expertise, that is, an illusion or actual control over the game (Cantinotti, Ladouceur, & Jacques, 2004; Ladouceur, Giroux, & Jacques, 1998; Myrseth, Brunborg & Eidem, 2010). Existing research on this has mixed findings. Research has shown that knowledge about the game and betting skills can be advantageous and valuable in sports betting (Burger, 1991; Rogers, 1998; Turner & Fritz, 2001). Studies have also found that in skill-based gambling, players can make money if they have better information and knowledge than other players (Turner & Barry, 2001).

However, other studies have suggested there is significant confusion between chance and skill in sports betting, and have proposed that knowledge and skills do not benefit the gambler's wins on horseracing (Ladouceur et al., 1998) or sports betting (Cantinotti et al., 2004). In these studies, it was suggested that sports bettors' skills are manifested by the gambler's cognitive distortions and are not genuine skills (Cantinotti., et al 2004). In a study by Ladouceur et al. (1998), it was found that expert bettors on horse-racing had strong erroneous beliefs regarding their ability to predict outcomes more accurately than chance. Their research showed that information and statistics regarding the strengths and weaknesses of horses did not result in more success, and rather, it was manifested by the gambler's illusion of control, (Cantinotti et al., 2004; Ladouceur et al., 1998). When people make decisions, engage in continuous involvement, and gain game knowledge, beliefs in personal control rise. In the field of skill-based gambling, previous research has attributed overconfidence and hopeful expectations of winning to the theory of illusion of control, (Langer 1975; Myrseth et al., 2010).

An element that has not received any attention in existing research regarding the actual skill of problem gamblers who participate in skill-based activities, is whether those who gamble on skilled games possess better numerical reasoning or understanding of gambling odds than those who gamble on chance.

1.5 Numerical Reasoning and Knowledge of Odds

Previous research suggests that problem gamblers who prefer skill games score higher on illusion of control than those who prefer chance, and therefore they overestimate their control over winning (Myrseth et al., 2010). However, previous research has shown that not all results are in the direction expected. For example, knowledge of gambling odds does not appear to differ between problem and non-problem gamblers (Lambos & Delfabbro, 2007) as might be expected by those who attribute erroneous beliefs to a lack of knowledge about gambling. Similarly, somewhat counter intuitively, gamblers and regular non-problem gamblers generally do not always differ in terms of their numerical reasoning skills (Lambos & Delfabbro, 2007). These findings are supported by other studies which show that decision-making quality does not always differ between strategic (skill-based) and non-strategic (chance-based) gamblers (Grant et al., 2012) and that having a better knowledge in probability and statistics does not necessarily make people more resistant to developing erroneous perceptions (Benhsain & Ladouceur, 2004). Similarly, a study by (Delfabbro, Lahn, & Grabosky, 2006) found that young problem gamblers responded more accurately to objective odds (e.g., the likelihood of certain outcomes in a coin toss), even though they over-estimated the skill level involved in activities based on chance. Delfabbro et al., (2006) argued that this demonstrated that differences in knowledge of odds or numerical reasoning skill might not be the foundation of cognitive reasoning differences between problem and non-problem gamblers.

Prior to this research, it was assumed that irrational thinking in a gambling context was linked to lack of mathematical and statistical knowledge, and that reducing problem gambling could be achieved by informing gamblers about the realistic odds of gambling, (Lambos & Delfabbro, 2007). However, this earlier work did not focus on the type of gambler. If problem gamblers are more likely to gamble on a wider range of activities including more skill-based activities, it may be that this explains some of the difference in the cognitions endorsed (e.g., they may have a reason to report skill in their gambling).

1.6 Current Approach to Gambling Therapy

Cognitive and cognitive behavioural therapy (CBT) methods are integral to the treatment of addiction (Kouimtsidis, Reynolds, Drummond, Davis, & Tarrier, 2007), and CBT is recognised as the practice strategy with the most empirical support in the field of problem gambling (Petry, 2005; Walker, 1992). Most cognitive therapy approaches to gambling are centred around an assumption that beliefs are erroneous or irrational, (Tarrier, 2011), and these beliefs are the reason problematic behaviour is ongoing and maintained. Current cognitive therapy interventions for problem gambling target unhelpful patterns of thinking relating to gambling, particularly challenging irrational views relating to chance, randomness and probabilities. These approaches stem from earlier work in the field of anxiety and depression (Beck, 1997; Ellis, 1962). A substantial body of research now supports the primary assumptions central to cognitive approaches, most of which relate to control over chance-based outcomes and probability. It is suggested that if these erroneous beliefs are identified and subsequently challenged, discredited or corrected, this will then encourage and empower more suitable and effective decisions, which subsequently reduces harms related to gambling behaviour, (Walker, 1992). Furthermore, approaches that

challenge these beliefs have been found to reduce overall symptoms of problem gambling (Gooding & Tarrier, 2009; Ladouceur et al., 2003; Ladouceur & Sylvain, 1999).

With the rise of accessibility and use of online sports betting in recent years, treatment services are now faced with an increasing proportion of people with problems related to sports-betting and other skill based gambling activities. A challenge is that many existing cognitive approaches to gambling therapy are largely focused on addressing maladaptive patterns of thinking, particularly false beliefs about chance and randomness and control over chance-based outcomes. However, despite the fact that both types of gambling are similar in structure, one must question the suitability of a focus on erroneous beliefs, chance and probabilities for skill-based gambling activities, and whether the current cognitive strategies are translatable to forms of gambling that involve an element of skill.

Unlike chance-based gambling activities, gambling activities such as sports betting, horse racing and card games arguably involve an association between player strategy or decision and outcomes. Unlike chance based gambling, which is thought to be sustained by irrational beliefs of long-term profitability, skill-based gambling may be maintained by consistent over estimation of skills. Actions taken by skilled gamblers can be considered deterministic, which is, that a player's input and decision-making can determine outcomes. Furthermore, there may be an assumption if one perseveres using one's skill in the correct way for long enough, the gambler will be rewarded.

It is therefore proposed that sports and more skill-based betting are likely to be maintained and driven by a wider or different range of cognitive beliefs, and hence, it may not be effective to continue to apply chance-based approaches relating to skill and

randomness with this group. It may be the incorrect approach to tell problem gamblers that there is 'no skill involved' or "it is all random". As there might be a real element of skill involved in skill-based gambling, cognitive approaches currently used for gambling might not be generalised to skilled gamblers. Due to the fact that gambling severity is traditionally associated with level of irrational cognitive beliefs, addressing these cognitive beliefs is a critical step to overcoming problem gambling. Therefore, it is necessary, in research and in practice, to reassess the relevant cognitive factors involved in the preservation of behaviours in gambling games of skill, and whether there are separate cognitive reasoning processes from what is seen in chance-based games that may contribute to ongoing and maladaptive gambling behaviour.

1.7 The Present Study

This study builds upon the earlier work of Lambos et al. (2007), which examined whether differences in numerical reasoning or knowledge of odds might explain the greater endorsement of erroneous beliefs by problem gamblers. In this study, this work is extended by including comparisons of skill and chance based gamblers (both problem and non-problem gamblers) and also a wider range of dysfunctional beliefs that might be more suitable to explain persistent gambling on skill-based activities. The study will utilise a 2 Gambler group (Problem and non-Problem) x 2 Skill / Chance Activity Preference factorial design to investigate the following hypotheses:

1. Problem gamblers will endorse more erroneous beliefs than non-problem regular gamblers on standardised measures.
2. Problem gamblers will endorse more cognitions relating to the use of skilful play than non-problem regular gamblers.

3. There will be no significant difference between problem gamblers and non-problem regular gamblers in their knowledge of gambling odds or numerical reasoning skills (as based on the previous study by Lambos et al. (2007).
4. Gamblers with a preference for skilled games will score higher on numerical reasoning than gamblers with a preference for chance games.
5. Gamblers with a preference for skilled games will score higher on broader skill-based cognitions than gamblers with a preference for chance games.
6. Problem gamblers with a preference for skilled games will score highest of all four groups on skill-based cognitions.

CHAPTER TWO: METHOD

2.1 Participants

A total of 152 participants (99 male, 53 female) who ranged in age from 20 to 80 years in age (M = 53.31, SD = 15.91) participated in the study. Participants had to be over 18 years of age, (i.e. above the legal age for Gambling in South Australia) and fluent in English. Participants were included if they classified as a problem or non-problem gambler on the Problem Gambling Severity Index ('PGSI'). Participants were classified as problem gamblers if they had a score of 8 or above on the Problem Gambling Severity Index, which indicates problem gambling with negative consequences and a possible loss of control. Participants were classified as non-problem, regular gamblers if they gambled fortnightly, and scored between 0 and 2 on the PGSI. This score indicates non-problem or low levels of problems with few or no identified negative consequences. The study involved four sample groups: problem gamblers with a preference for skill-based gambling activities (*n* = 23); problem gamblers with a preference for chance-based gambling activities (*n* = 26); non-problem regular gamblers with a preference for skill-based gambling activities (*n* = 44) and non-problem regular gamblers with a preference for chance-based gambling activities (*n* = 59). Participants were recruited from two sources.

2.2 Sampling and Survey Procedure

Eligible participants who classified as problem gamblers per the PGSI (i.e. scores of 8 and above), were initially sourced from PsychMed Pty Ltd, a private psychology clinic that is the current provider of the South Australian Intensive Gambling Help Service. These participants were invited to participate via email and post (Appensix B), which provided a URL to the online survey. An additional sample of problem gamblers and a sample of non-problem, regular gamblers were recruited from the community, using an online panel

recruitment service, Qualtrics. Qualtrics sourced participants who gambled at least fortnightly and scored between 0-2 or over 8 on the PGSI. All data were collected using an online survey hosted by Survey Monkey or Qualtrics.

2.3 Measures

2.3.1 Demographics, Gambling Frequency and Preference

Firstly, demographic information (age and gender), were obtained from the participant. Participants were asked if they had gambled in the last two weeks and how often they gambled in the last 12 months (Once a day, 2-3 times a week, once a week, once a fortnight, once a month, less than once a month). Participants were then asked about the type of gambling they most frequently engaged in over the last 12 months, the type of gambling activity they spent the most money on in the last 12 months, and their gambling frequency and involvement in the following categories: horse/greyhound racing, sports betting, gambling machines, casino table games, card games, lottery products, keno, internet gambling or private gambling.

2.3.2 Problem Gambling Severity Index (PGSI)

The PGSI is a self-report measure which features nine items, four that measure problem gambling behaviours (e.g. How often have bet more than your could afford to lose?) and five that measure adverse gambling consequences (e.g. How often have you felt you might have a problem with gambling?) (Ferris, Wynne, & Single, 1999). Participants answer on a four-point Likert-style scale (0 = never, 1 = sometimes, 2 = most of the time, 3 = almost always), with an overall score ranging between 0 and 27. The PGSI was used to assess gambling severity, and to distinguish between problem and non-problem gamblers.

2.3.3 Gambling Related Cognitions Scale

The Gambling Related Cognitions Scale is an indicator of gambling related cognitions and is a positive predictor of problem gambling, (Raylu & Oei, 2004). It measures gambling expectancies, illusion of control, predictive control, inability to stop gambling and interpretive bias. The higher total score indicates a higher number of gambling related cognitions for the participant. It is a self-report measure consisting of 22 items, which are rated on a 7-point Likert scale ranging from 1 (strongly disagree) to 7 (strongly agree).

2.3.4 Skill Based Gambling Cognitions

Internet Gaming Cognition Scale

The Internet Gaming Cognition Scale is a 24-item self-report measure that assesses problematic cognitions relating to Internet Gaming Disorder, (King & Delfabbro, 2014; King & Delfabbro, 2016). Many elements of internet gaming addictions cross over with gambling habits, especially in relation to internet games that involve skill. Eleven items of this scale were selected on their capacity to assess skill-based cognitions and adapted to reflect beliefs about involvement of skill in gambling. For example, an item that read, “I spend time planning or thinking about video-games when I am not playing” was modified to, “I spend time planning or thinking about gambling when I am not gambling”. Items were rated on a 3-point Likert scale (0 = Do Not Agree, 1 = Agree, 2 = Strongly Agree).

Gambling Cognitions Inventory

The Gambling Cognitions Inventory is a 33-item self-report measure that measures cognitive distortions that are typically related to etiological factors in problem gambling, (McInnes, Hodgins, & Holub, 2014). 5 items of the Gambling Cognitions Inventory were selected on their skill-based properties, for example, “I am a very skilled gambler” and “I am

very confident about my gambling ability". Items were rated on a 4-point Likert scale ranging from 1 (strongly disagree) to 4 (strongly agree*).*

2.3.5 Knowledge of Gambling Related Odds

Participants were asked four questions concerning common gambling related odds. All questions had five options, with one being correct or closest to the correct answer. These questions were previously developed and used in Lambos & Delfabbro's (2007) research, and tested respondents' understanding of the odds relating to common gambling activities. Firstly, participants were asked to select the set of odds that was most likely associated with winning the lottery, with 6 numbers being correct out of 45. Answers ranged from 1 in 100,000 to 1 in 10 million, with the most correct answer being 1 in 8 million. Participants were then asked, if two coins were tossed, what the chances are of getting two heads. Answers ranged from 10% to 50%, with the correct answer being 25%. A third question asked participants, if a poker machine returned 87% to the player and a person plays $20, how much would the player expect to lose. The correct answer was $2.60. Lastly, participants were asked the likelihood of drawing an ace from a deck of 52 cards. Answers included 1 in 52, 2 in 52, 2 in 26 or none of the above, with the correct answer being 4 in 52.

2.3.6 Numerical Reasoning Ability

Participants completed two tests that measured their numerical reasoning skills: the Psytech International GRT2 General Reasoning Test (Psytech International, 1991) and the Cognitive Reflection Test, (Frederick, 2005).

Psytech International GRT2 General Reasoning Test

The numerical section of the General Reasoning Test is a standardised test that measured participants' understanding of numbers and relationships between numbers, and their "ability to use and manipulate numbers in a logical way", (Psytech International, 1991). This particular test has been found to have strong psychometric properties and has been validated extensively across national and international samples. The test begins with 3 example questions before completing 25 assessed questions, with each question containing 6 possible answers. Questions include, "1, 2, 4, 7, 11, 16,… What number comes next?" with possible answers, "18, 24, 23, 19, 22 or 21". The test stipulates that the 25 questions should be timed and completed within 10 minutes. Unfortunately, the software used did not allow for timed sections, so participants were advised to aim to complete the test within the specified time frame.

Cognitive Reflection Test

The Cognitive Reflection Test is a 3 item self-report measure is designed to capture a person's tendency to override an initial incorrect response and employ further reflection that results in the correct answer, (Frederick, 2005). The first question is as follows, "A bat and a ball cost $1.10 in total. The bat costs $1 more than the ball. How much does the ball cost?". The test has strong correlations with measures of thinking, including numerical thinking, (Szaszi, Szollosi, Palfi, & Aczel, 2017).

2.4 Procedure

Problem and regular non-problem regular gamblers participated in an online survey containing eight measures (Appendix A). Problem gamblers sourced from PsychMed were invited to participate via email and post (Appendix B). This invitation contained a brief

description of the study and an invitation for the recipient to participate. It included a link to the online survey on SurveyMonkey, where they were directed to the Participant Information Sheet as a prelude to entering the survey (Appendix C). Participants were asked to read the Information Sheet thoroughly and provide consent to partake in the study by clicking a check box (Appendix D). With consent from the participant, previous data collected from PsychMed was obtained, including participant demographics and results on the PGSI. As compensation for their time and effort, PsychMed problem gamblers provided an email or postal address at the end of the survey, to receive a Myer voucher to the value of $20.00, which was non-redeemable for cash. Participants had the opportunity to provide an email address to receive feedback via a copy of the final report.

An additional sample of problem gamblers and non-problem regular gamblers were sourced via an online panel service, Qualtrics. Participants were invited to participant if they gambled fortnightly and classified as a problem gambler or non-problem regular gambler per the PGSI. These participants were also provided the Participant Information Sheet (Appendix C) and agreed to the Consent Form (Appendix D) prior to beginning the survey. Qualtrics participants were compensated via Qualtrics after survey completion. Due to confidentiality agreements, Qualtrics participants could not nominate an email address to receive feedback. The study was accessible from a personal or public device and took approximately 15 minutes to complete.

2.5 Ethics

This project was approved by the University of Adelaide's Human Research Ethics Committee and PsychMed Pty Ltd's Ethics Committee. Consent was obtained from each participant via an online consent form (Appendix D). Participants were asked to answer

questions regarding their thoughts about their own gambling habits and experiences. Any risks of psychological discomfort for participants were mitigated by the supply of support phone numbers at the beginning and completion of the survey. For South Australian participants, PsychMed's South Australian Intensive Gambling Help Service helpline was also be offered, and if eligible, participants were able to access further gambling services free of charge if needed. The questions contained in the measures were predominately centred on the participants' general views towards their gambling rather than gambling experiences or any personal losses (Appendix A), which minimised the risk of discomfort. Privacy and confidentiality was protected by removing personal identifiers and replacing with coded data. Financial support for data collection was provided by the principal supervisor and no Honours budget was used.

CHAPTER 3: RESULTS

3.1 Preliminary Analyses and Statistical Procedures

Preliminary analyses that consisted of screening the data for outliers and testing that the data was suitable for parametric testing was conducted before commencing analyses. Through examination of histograms, normality plots and box plots, three scores on the PGSI, 1 score on the GRCS and 1 score on the IGCS were identified as outliers. It was found the 3 outliers on the PGSI did not have a significant effect on results, so they were included in the final analysis. The two outliers on the GRCS and IGCS were removed from the data set.

Analyses included exploring descriptive statistics for demographics and measures, as well as a series of chi-squared analyses to test the relationship between the main categorical variables: gambler status, gender and gambling type. A number of t-tests were then performed to test the main effects of gender on outcome measures. This was followed by a series of 2 x 2 Analysis of variance (ANOVA) to test the main effects and interactions between gambling status (gambling group) and gambling preference (skill/chance activities) in relation to scores on the key measures. All tests used a significance level of 0.05.

3.2 Descriptive Statistics

3.2.1 Demographics

As seen in Table 3.1, 49 (32.2%) participants classified as problem gamblers ('PG') per the PGSI and 103 (67.8%) participants classified as non-problem regular gamblers ('NPG') who gambled at least fortnightly. Sixty-seven (44.1%) participants gambled predominantly on skill-based gambling activities and 85 (55.9%) gambled mostly on chance-based gambling activities.

Table 3.1

Number of chance and skill-based problem and non-problem regular gamblers.

		Chance *n*	Skill *n*	Total *n*
Problem Gambling Status	NPG	59	44	103
	PG	26	23	49
Total		85	67	152

As shown in Table 3.2, Lottery products were the most commonly reported gambling activity, followed by horse/greyhound racing, gaming machines, sports betting, and Keno. Other activities tended to attract a low proportion of participants.

Table 3.2

Percentages of participants in various gambling activities.

Gambling Activity	PG (*n* = 49) *n* (%)	NPG (*n* = 103) *n* (%)	Total (*n* = 152) *n* (%)	X^2
Horse/greyhound racing	10 (6.6)	29 (19.1)	39 (25.7)	1.05
Sports betting	12 (7.9)	14 (9.2)	26 (17.1)	2.78
Gaming Machines (Pokies)	14 (9.2)	18 (11.8)	32 (21.1)	2.46
Casino Table Games	2 (1.3)	0 (0.0)	2 (1.3)	4.26*
Card Games	1 (0.7)	1 (0.7)	2 (1.3)	.29
Lottery Products	6 (4.0)	37 (24.3)	43 (28.3)	9.18*
Keno	2 (1.3)	2 (1.3)	4 (2.6)	.59
Internet gambling	2 (1.3)	2 (1.3)	4 (2.6)	.59

* $p < .05$

3.2.2 Gambler Status, Gender and Gambling Participation

A series of 2 x 2 chi-square tests of independence were conducted to examine associations between categorical variables (gambler group, type of gambling and gender). Results showed that the relationship between problem gambler status and type of gambling (i.e. skill or chance) was non-significant, χ^2 (1, N = 152) < 1 (V = .04). Table 3.2 shows chi-square values for participation in each activity and gambler status, which indicates that only casino table games, χ^2 (1, N = 152) = 4.26, p = .04, (V = .17), and lottery products, χ^2 (1, N = 152) = 9.18, p <.05 (V = .25), were significantly associated with gambler status.

Three chi-square analyses were used to assess if associations existed between gender and gambler status, and gender and preference for skill or chance games. There was a non-significant association between gender and problem gambling status, χ^2 (1, N = 152) = 2.21, p = .14, (V = .12), and a significant association between gender and preference for skill or chance games, χ^2 (1, N = 152) = 15.17, p < .001, (V = .32).

Table 3.3

Number of female and male skill and chance-based gamblers.

	Gender		
	Female	*Male*	*Total*
Chance	41	44	85
Skill	12	55	67
Total	53	99	152

Independent samples t-tests were used to compare male and female means on outcome measures, and whether any differences were significant. As seen in Table 3.4, males scored slightly higher than females on the PGSI, IGCS and CRT, but these differences were non-significant. Males scored significantly higher on the GRCS, GCI, knowledge of odds and numerical reasoning tests. All effect sizes were medium according to Cohen's d: GRCS (.38), knowledge of odds (.39) and numerical reasoning (.42), and a medium to large effect size for the GCI (.61).

Table 3.4

Gender differences for the principal psychometric measures.

	Male (n = 99)	*Female (n = 53)*			
	M(SD)	*M(SD)*	*t*	*Cohen's d*	*p*
PGSI	5.58(7.53)	4.30(7.26)	1.01	0.17	.32
GRCS	70.59(31.60)	58.40(32.79)	2.24	0.38	.03
IGCS	4.99(5.56)	3.26 (5.38)	1.84	0.32	.07
GCI	5.90(4.27)	3.25 (4.41)	3.61	0.61	< .001
Knowledge of Odds	1.84(1.02)	1.42(1.13)	2.35	0.39	.02
Numerical Reasoning	16.35(6.25)	13.81(5.84)	2.45	0.42	.02
CRT	.70(.94)	.45(.77)	1.62	.29	.11

PGSI = Problem Gambling Severity Index; GRCS = Erroneous Cognitions; IGCS; Skill-Related Cognitions, CGI: Skill-Related Cognitions; CRT = Cognitive Reasoning Test

3.2.3 Correlations

Table 3.5 shows Pearson correlations between outcomes measures and gender. Increases in PGSI scores were significant correlated with increases in GRCS, IGCS, GCI and CRT scores. Increases in PGSI had a significant negative correlation with numerical reasoning scores. Significant positive correlations were also found between GRCS scores and IGCS and GCI scores. Significant negative correlations were found between GRCS scores and numerical reasoning scores. IGCS scores and GCI scores were significantly positively correlated, and IGCS scores had a significant negative correlation with numerical reasoning and CRT scores. Knowledge of odds scores had significant positive correlations with numerical reasoning and CRT scores, and numerical reasoning and CRT scores were significantly positively correlated. Gender had significant negative correlations with scores on the GRCS, GCI, knowledge of odds and numerical reasoning.

Table 3.5

Pearson correlations between measures.

	PGSI	GRCS	IGCS	GCI	Knowledge of Odds	Numerical Reasoning	CRT
PGSI							
GRCS	.71**						
IGCS	.73**	.83**					
GCI	.432**	.73**	.80**				
Knowledge of Odds	-.01	.02	.06	.11			
Numerical Reasoning	-.25**	-.21*	-.24**	-.10	.53**		
CRT	.18*	-.12	-.18*	-.06	.49**	.59**	

PGSI = Problem Gambling Severity Index; GRCS = Erroneous Cognitions; IGCS; Skill-Related Cognitions, CGI: Skill-Related Cognitions; CRT = Cognitive Reasoning Test

*p < .05 ** p < .01

3.3 Two-way Factorial ANOVA

A 2 Gambling Preference (Skill/Chance) x 2 Gambler Group (PG/NPG) factorial ANOVA was run to determine the main effects of problem gambling status (gambling group/severity) and gambling preference (skill or chance-based activities) on outcome measures. These analyses also determined if problem gambling status and gambling preference had a significant interaction effect on outcome measures.

3.3.1 GRCS Scores

A two-way ANOVA was conducted to determine if there was an interaction between problem gambling status and skilled gambling preference on general gambling cognitions (GRCS). As shown in Table 3.6, problem gamblers endorsed more erroneous beliefs than non-problem regular gamblers, and there was a significant main effect of problem gambling status on GRCS scores, F (1, 148) = 145.87, $p < .001$. This supported the first hypothesis that problem gamblers would endorse more erroneous beliefs than non-problem regular gamblers. There was a significant main effect of gambling preference on GRCS scores, F (1, 148) = 5.30, $p = .02$, and a non-significant interaction between problem gambling status and gambling preference on GRCS scores, F (1, 148) = 1.44, $p = 0.23$.

3.3.2 IGCS Scores

Problem gamblers scored higher on the IGSS than non-problem regular gamblers, and there was a significant main effect of problem gambling status on IGCS scores, F (1, 148) = 140.65, $p < .001$. This supported hypothesis two, that problem gamblers would endorse more cognitions relating to the use of skilful play than non-problem regular gamblers. Similarly, in support of hypothesis five, skill-based gamblers scored higher on the IGCS than chance-based gamblers and there was a significant main effect of gambling preference on IGCS, F

(1, 148) = 17.29, p < .001. The interaction between gambling severity and gambling preference on skill-related cognitions in the IGCS was significant, *F (*1, 148) = 6.61, *p* = 0.01, which supports the sixth hypothesis and indicates that problem gamblers with a preference for skill-based activities were more likely to score highest on the IGCS and endorse skill-related cognitions.

3.3.3 GCI Scores

Problem gamblers scored higher than non-problem regular gamblers on skilled cognitions in the CGI and there was a significant main effect of problem gambling status on GCI scores, *F* (1, 148) = 39.03, p < .001. Skill-based gamblers endorsed more skill-related gambling cognitions and there was a significant main effect of gambling preference on GCI scores, *F* (1, 148) = 26.16, p < .001. These results supported hypotheses two and five. The sixth hypothesis, that problem gamblers with a preference for skilled games would score highest of all four groups on skill-based cognitions, was not supported for the GCI, as there was a non-significant interaction between gambling severity and gambling preference on skill-related cognitions in the GCI, *F* (1, 148) = .072 , *p* = .79.

3.3.4 Knowledge of Odds Scores

In support of hypothesis three, there was a non-significant main effect of problem gambler status on knowledge of odds scores, *F* (1, 148) = .36, *p* = .55, meaning there was no significant different between problem gamblers and non-problem regular gamblers in their knowledge of gambling odds. There was a non-significant main effect of gambling preference on knowledge of odds scores, *F* (1, 148) = 2.02, *p* = .16. The interaction between problem gambler status and gambling preference on knowledge of odds scores was not significant, *F* (1, 148) = .62, *p* = .43.

3.3.5 Numerical Reasoning

Results showed that non-problem regular gamblers scored higher on the numerical reasoning test than problem gamblers, and there was a significant main effect of problem gambler status on numerical reasoning scores, F (1, 148) = 4.44, p = .04. This did not support hypothesis three which predicted there would be no difference between problem gamblers and non-problem gamblers on numerical reasoning scores. As shown in Table 3.6, gamblers who preferred skilled games scored higher on the numerical reasoning test than gamblers who preferred chance games, but this main effect was non-significant and did not support the fourth hypothesis, F (1, 148) = .39, p = .53. There was a significant interaction between problem gambler status and gambling preference on numerical reasoning skills, F (1, 148) = 4.02 , p =.05, which indicates that non-problem gamblers with a preference for skill-based activities were more likely to score highest on numerical reasoning.

3.3.6 CRT Scores

As shown in Table 3.6, non-problem gamblers scored higher on the CRT than problem gamblers, and there was a significant main effect of problem gambler status on CRT scores, F (1, 148) = 5.02, p = .03. This did not support the third hypothesis that there would be no significant difference between groups. Although skill-based gamblers scored higher on the CRT, the fifth hypothesis was not supported as there was a non-significant main effect of gambling preference on CRT scores, F (1, 148) = .75, p = .39. Lastly, there was a non-significant interaction between problem gambler status and gambling preference on CRT scores, F (1, 148) = 1.50, p = .22.

Table 3.6

Mean (SD) scores on the PGSI, GRCS, GCI, Knowledge of Odds, Numerical Reasoning, and CRT.

	Skill Preference (*n = 67)*		Chance Preference (*n = 85)*		Overall *(n = 152)*
	PG (n=23) *M(SD)*	*NPG (n = 44)* *M(SD)*	*PG (n=26)* *M(SD)*	*NPG (n = 59)* *M(SD)*	*(n = 152)* *M(SD)*
PGSI	15.83(5.6)	.41 (.7)	13.77(6.0)	.68 (.9)	5.13(7.404)
GRCS	106.57(23.7)	53.27(21.5)	92.50(26.6)	48.86(22.2)	66.34(32.4)
IGCS	12.22(5.6)	2.43(2.9)	7.65(6.0)	1.36(2.3	4.39(5.5)
GCI	9.48(3.8)	5.61(3.9)	6.35(4.9)	2.14(2.9)	4.97(4.9)
Knowledge of Odds	1.70(.9)	1.95(1.1)	1.58(1.2)	1.54(1.1)	1.69(1.1)
Numerical Reasoning	13.35(6.6)	17.70(5.7)	14.81(6.3)	14.92(6.0)	15.47(6.2)
CRT	.22(.5)	.75(1.0)	.54(.8)	.69(1.0)	.61(.9)

PG = Problem Gambler; NPG = Non-Problem Regular Gambler; PGSI = Problem Gambling Severity Index; GRCS = Erroneous Cognitions; IGCS; Skill-Related Cognitions, CGI: Skill-Related Cognitions; CRT = Cognitive Reasoning Test

Table 3.7

Two-Way ANOVA Results.

Measure	Main effect Gambler Group F (η^2)	Main effect Skill/Chance F (η^2)	Interaction F (η^2)
GRCS	145.87 (.50)*	5.30 (.04)*	1.44 (.01)
IGCS	140.65 (.49)*	17.29 (.11)*	6.61 (.04)*
GCI	39.03 (.21)*	26.16 (.15)*	.072 (.00)
Knowledge of Odds	.36 (.00)	2.02 (.01)	.62 (.00)
Numerical Reasoning	4.44 (.03)*	.39 (.00)	4.02 (.03)*
CRT	5.02 (.03)*	.75 (.01)	1.50 (.01)

GRCS = Erroneous Cognitions; IGCS; Skill-Related Cognitions, CGI: Skill-Related Cognitions; CRT = Cognitive Reasoning Test

* $p < .05$; Eta-sq: .01 small, .08 mod, .14 large

CHAPTER 4: DISCUSSION

4.1 Overview of the Main Findings

The present study aimed to support findings from previous research that problem gamblers would endorse more erroneous beliefs than non-problem regular gamblers, and that these groups would not differ on their level of numerical reasoning skill, (Lambos & Delfabbro, 2007). The present study also tested the assumption that skilled gamblers may endorse a wider range of cognitive beliefs relating to skilful play in gambling, and may have greater skills in mathematical reasoning than chance-based gamblers. Analysis of these relationships provided insight into the potential differences between gamblers depending on preference of gambling type (skill or chance) and what implications this might have for gambling-related cognitive therapy approaches.

There was partial support for hypotheses one through six. Results supported hypotheses one and two, and problem gamblers were found to endorse more erroneous beliefs and report more cognitions relating to the skilful play than non-problem regular gamblers. The first component of the third hypothesis was supported; no significant difference was found between problem gamblers and non-problem regular gamblers in their understanding of common gambling odds. However, gambling severity was found to have a significant main effect on numerical reasoning skills, which did not support the third hypothesis. Hypothesis four was not supported, as gamblers with a preference for skilled games did not score more accurately than gamblers with a preference for chance games when assessed on mathematical reasoning. Hypothesis five was supported, and skill-based gamblers endorsed more cognitions relating to skilful play than chance-based gamblers. The final hypothesis was partially supported; problem gamblers with a preference for skill-based

activities scored highest of all groups on one measure of skill-based cognitions (IGCS) but not the other (GCI).

4.2 Erroneous Beliefs and Skill-Related Cognitions

The finding that problem gamblers endorsed more erroneous beliefs supports previous research where problem gamblers have typically reported higher levels of irrational beliefs and hold these beliefs with more conviction (Sevigny & Ladouceur, 2004; Ladouceur, 2004; Toplak et al, 2007; Delfabbro & Winefield, 2000; Griffiths, 1995; Walker, 1992a; Mysreth et al. 2010). This finding is consistent with cognitive theory for gambling which suggests that problem gamblers cannot comprehend the true nature of chance and randomness in gambling. These erroneous beliefs can be explained by Toplak et al's (2007) theory of system failures in adaptive processing, where the analytical system fails to identify and correct irrational beliefs in the automatic interpretation of information. The present study also found that problem gamblers are more likely to report more skill-related cognitions than non-problem regular gamblers. This finding denotes that there is a perceived ideation of skill held by problem gamblers, whether or not the gambler partakes in skill or chance-based gambling. Gamblers therefore over-estimate how much skill can impact outcomes and ability to win.

Skill-based gamblers were also found to endorse more cognitions relating to skilful play than chance-based gamblers. This provides sufficient evidence that there is a meaningful distinction between the cognitive biases contributing to gambling activities of skill and chance, and gamblers with a preference for skill-based activities have more conviction in the way in which their skills can impact the activity and control their gambling outcomes. Once again, this means skill can be over-estimated even in skill-based gambling where there is an element of genuine skill. This finding is linked to previous research where increased levels of

general gambling-related erroneous beliefs were found in activities that involved skill (Toneatto et al., 1997), and added an element of skill created a greater irrational sense of control in skill-based gamblers (Myrseth et al., 2010; Toneatto et al., 1997). This finding also supports Cantinotti et al. (2004) where skills of sports bettors were suggested to be manifested by irrational cognitive beliefs, rather than reflecting actual skill.

As anticipated, skill-based problem gamblers endorsed the most skill-based cognitions on a skill-related cognition scale. This provides some evidence that there is a distinction between the four gambling groups and problem gamblers who gamble on skill endorse different cognitive beliefs to other gamblers. Hence, it suggests an explanation as to why skill-based problem gamblers continue to gamble despite adverse and financial consequences. It also suggests that skill-based problem gamblers justify their gambling decisions and choose to continue to gamble because they believe their level of skill is supporting their success.

4.3 The role of Numerical Reasoning Ability in Erroneous Belief

The present study also considered the role of numerical reasoning in different gambling groups. Findings that problem gamblers and non-problem regular gamblers did not differ in their understanding of common gambling odds confirmed previous research by Lambos & Delfabbro (2007) that both groups of gamblers display similar understanding of gambling odds and higher levels of irrational beliefs cannot be attributed to poorer statistical ability. However, gambling severity was found to have a significant main effect on numerical reasoning skills, where non-problem gambles were more accurate than problem gamblers, which is not consistent with predictions of the present study or previous research by Lambos and Delfabbro (2007). Findings also showed that skill-based gamblers were not more

accurate in numerical reasoning than chance-based gamblers. This did not support predictions of the present study and instead, contributes to disproving the assumption that skill-based gamblers have more numerical knowledge and are therefore more skilful gamblers. The findings did, however, show that skill-based gamblers had strong conviction in skill-related gambling cognitions. It may therefore be inferred that a combination of strong endorsement of skill-related cognitions and insignificant numerical skill leads to an overestimation of skill.

4.4 Strengths and Limitations

This study has a number of strengths. It is the first to consider and compare skill-specific cognitive beliefs and numerical reasoning skill between skill-based and chance-based gamblers. It also used empirically validated measures (PGSI, GRCS, Numerical Reasoning & CRT) as well as items (knowledge of odds questions) that had previously been used in significant experiential research. The sample size for the study was suitable for the analyses undertaken and the study. Another important element was that all people were regular gamblers so that the study avoided the problem evident in studies that use non-gamblers or students as the lower risk comparison group. A failure to do this means that any differences observed for problem gamblers could be due to their experience with gambling (the regularity of playing) as well as their status as problem gamblers. (Orford, 1985). To avoid this confound, fortnightly gambling frequency was matched across the sample, for problem and non-problem gamblers.

However, it is important to also acknowledge several limitations. Firstly, females were underrepresented across all sample groups, which is likely due to there being fewer female gamblers in the community, (Desai, Maciejewski, Pantalon & Potenza, 2005). In particular, males were much more prone to gambling on skill-based activities than females,

which is a common observation not only in gambling studies but also in the wider community, (Toneatto, 1997). Hence, some of the outcome measures (GRCS, CGI, knowledge of odds and numerical reasoning) suffered from gender differences, which may have had an effect on results and made some results more attributable to gender differences. It was also difficult to attain equal sample sizes of problem and non-problem gamblers, meaning the non-problem group had increased numbers in both the skilled and chance sample. Skilled gamblers were also slightly underrepresented compared to chance. It is also important to consider that the measures assessing cognitive biases and erroneous beliefs (GRCS, IGCS & GCI) were all answered in a self-report manner. As per all self-report measures, this format makes it challenging to ascertain true beliefs, as participants are likely to respond in a way that is socially desirable, and in this case, in a way that reflects positive, rational decision-making. Lastly, it is important to consider that many respondents engaged in multiple forms of gambling over the previous twelve months. Results were based on the type of gambling they engaged in most frequently; however, it is difficult to know whether participants answered questions thinking about their involvement in skill or chance activities when questioned about their beliefs.

4.5 Implications on Gambling-Related Cognitive Therapy

Due to the rising involvement in skill-based gambling over the last decade and an increasing demand for appropriate and effective treatment services for problem gamblers who gamble on skill-based activities, an important aim of the present study was to assess the suitability of current cognitive therapy techniques for skill-based problem gamblers. As discussed above, the results of the present study propose that skill-based problem gamblers believe they are skilful and their skills assist in their rewards. Hence, it is arguable that current therapy approaches centred around challenging erroneous believes about randomness

and probabilities may be less effective for this group and therefore require further development. This would need to include content that is more applicable to gambling that involves an element of skill. Suggestions for modifications to cognitive approaches could include an approach that focuses on challenging the cognitive and arguably irrational beliefs relating to skill and the deterministic actions of skill-based gamblers.

4.6 Future Directions

This research suggests that certain clusters of beliefs exist within skill-based gambling groups, which could be a focus for further research and application in clinical practice. A replication study using a more equally balanced sample of skill and chance-based gamblers would assist to confirm the findings of the present study relating to gambling severity, gambling type, erroneous beliefs, skill-related beliefs and numerical reasoning. Replication could also control for gender effects.

Future research in the field of skill-related cognitions and numerical reasoning ability could expand on the results of the present study, using the skill-related cognitions identified in the present study. Further research could include the development of measures that assess success or reward in skill based gambling against skill related cognitions, to allow for genuine skill levels to be assessed. Furthermore, it has been previously suggested (Smith, 2003) that differences in cognitive beliefs between problem and non-problem gamblers may actually reflect more subtle fallacies about probabilities and statistics, which are not identified by the types of questions used in current research, which suggests the need for further refinement in analyses of knowledge such as numerical reasoning.

4.7 Conclusions

The present study confirmed that erroneous gambling-related and specific skill-related cognitions are higher in problem gamblers and skill-based gamblers. It also confirmed that differences between problem and other gamblers is unlikely to be due to differences in understanding of gambling odds and that differences in numerical reasoning does not appear to relate to perceptions of skill in skill-based gamblers. These findings emphasise the importance of considering differences in gambling type when examining the maintenance of problem gambling and the need to adapt cognitive therapy to better suit those who gamble on skill-based activities.

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APPENDICES

Appendix A: Measures

Demographics

Q1 Have you gambled in the past two weeks?

- ○ Yes
- ○ No

Q4 Please select your gender

- ○ Male
- ○ Female
- ○ Other

Q5 What is your age?

_____

Q6 In the last 12 months, what type of gambling did you most frequently engaged in?

- ○ Horse/Greyhound Racing
- ○ Sports Betting
- ○ Gaming Machines (i.e. Pokies)
- ○ Casino Table Games
- ○ Card Games
- ○ Lottery Products
- ○ Keno
- ○ Internet Gambling
- ○ Private Gambling
- ○ Other (please specify) _____

Q7
In the last 12 months, how often have you gambled on:

	Once a day	2-3 times a week	Once a week	Once a fortnight	Once a month	Less than once a month	Not at all
Horse/Greyhound Racing	○	○	○	○	○	○	○
Sports Betting	○	○	○	○	○	○	○
Gaming Machines (i.e. Pokies)	○	○	○	○	○	○	○
Casino Table Games	○	○	○	○	○	○	○
Card Games	○	○	○	○	○	○	○
Lottery Products	○	○	○	○	○	○	○
Keno	○	○	○	○	○	○	○
Internet Gambling	○	○	○	○	○	○	○
Private Gambling	○	○	○	○	○	○	○

Q8 On which of the following types of gambling did you spend the most money in the last 12 months?

- ○ Horse/Greyhound Racing
- ○ Sports Betting
- ○ Gaming Machines (i.e. Pokies)
- ○ Casino Table Games
- ○ Card Games
- ○ Lottery Products
- ○ Keno
- ○ Internet Gambling
- ○ Private Gambling
- ○ Other (please specify) _____

Problem Gambling Severity Index (PGSI)

Please tick the appropriate box for each question below.

	Never	Sometimes	Most of the time	Almost always
When you think of the past 12 months, have you bet more than you could really afford to lose?	○	○	○	○
Still thinking about the last 12 months, have you needed to gamble with larger amounts of money to get the same feeling of excitement?	○	○	○	○
When you gambled, did you go back another day to try win back the money you lost?	○	○	○	○
Have you borrowed money or sold anything to get money to gamble?	○	○	○	○
Have you felt that you might have a problem with gambling?	○	○	○	○
Has gambling caused you any health problems, including stress	○	○	○	○

or anxiety?				
Have people criticised your betting or told you that you had a gambling problem, regardless of whether or not you thought it was true?	○	○	○	○
Has your gambling caused any financial problems for you or your household?	○	○	○	○
Have you felt guilty about the way you gamble or what happens when you gamble?	○	○	○	○

Gambling Related Cognition Scale (GRCS)

Q9 For each of the following statements, please mark the response that most closely reflects your thoughts about your gambling:

	Strongly disagree	Moderately disagree	Mildly disagree	Neither agree/disagree	Mildly agree	Moderately agree	Strongly agree
Gambling makes me happier	○	○	○	○	○	○	○
I can't function without gambling	○	○	○	○	○	○	○
Praying helps me win	○	○	○	○	○	○	○
When I am losing I think things will turn around and I will start to win	○	○	○	○	○	○	○
I keep gambling because I think I have specific skills and abilities that help me to win	○	○	○	○	○	○	○
Gambling makes things seem better	○	○	○	○	○	○	○
It is difficult to stop gambling as I am so out of control	○	○	○	○	○	○	○
Certain numbers	○	○	○	○	○	○	○

and colours will increase my chances of winning							
If I do lose, I learn from the experience which helps me to win next time	○	○	○	○	○	○	○
I keep gambling because my losses are due to 'bad luck' or 'bad circumstances'	○	○	○	○	○	○	○
Gambling makes the future brighter	○	○	○	○	○	○	○
My desire to gamble is overpowering	○	○	○	○	○	○	○
Certain objects or pictures help increase my chances of winning	○	○	○	○	○	○	○
When I win once, it is a definite sign I will win again	○	○	○	○	○	○	○
I keep gambling because my losses are due to 'probability'	○	○	○	○	○	○	○

Gambling helps me to reduce my stress levels	○	○	○	○	○	○	○
I'm not strong enough to stop gambling	○	○	○	○	○	○	○
I follow certain rituals that increase my chances of winning	○	○	○	○	○	○	○
I only gamble when I feel lucky	○	○	○	○	○	○	○
Rememberi ng my last big win keeps me gambling	○	○	○	○	○	○	○
I will never be able to stop gambling	○	○	○	○	○	○	○
I can predict when I am going to win	○	○	○	○	○	○	○
I am more likely to win if I keep the same systems in place (eg. machine, numbers, table etc.) than if I change them	○	○	○	○	○	○	○

Internet Gaming Cognition Scale (IGCS)

Q10 For each of the following statements, please mark the response that most closely reflects your thoughts about your gambling:

	Do Not Agree	Agree	Strongly Agree
When I make mistakes, lose progress, or fail in gambling, I must try again.	○	○	○
It would be a waste to stop gambling when I have already invested so much time and energy.	○	○	○
Rewards in gambling are as important to me as anything else in my life.	○	○	○
When I have a goal or objective in gambling, I must complete it as soon as possible.	○	○	○
I am proud of my gambling achievements.	○	○	○
I spend time planning or thinking about gambling when I am not gambling.	○	○	○
People who do not gamble do not really understand an important part of who I am.	○	○	○
It is important to me that I am better at gambling than other people (e.g. more skilful, higher returns).	○	○	○

Other gamblers admire and respect my gambling skills.	○	○	○
I feel more in control when I gamble.	○	○	○
If I complete or master an achievement, skill or goal in gambling, I feel good about myself.	○	○	○

Gambling Cognitions Inventory (GCI)

Q11 For each of the following statements, please mark the response that most closely reflects your thoughts about your gambling:

	Strongly Disagree	Somewhat Disagree	Somewhat Agree	Strongly Agree
I am a very skilled gambler.	○	○	○	○
I can analyse my wins to give me strategies to make me a better gambler.	○	○	○	○
I am very confident about my gambling ability.	○	○	○	○
I will get better at gambling with practice.	○	○	○	○
The more skilled at gambling I become the more money I expect to win.	○	○	○	○

Knowledge of Odds

Q12 In Cross-lotto on TV, there are 45 numbers and you must choose 6. Imagine if half of the people in Australia bought a ticket (that's 10 million people) each with one set of 6 numbers. How many people do you think would either win or share the big prize by guessing all 6 numbers correctly? (Please choose one response).

- ○ One person out of every 100,000 people
- ○ Only one person in every million people
- ○ Only one person in every 5 million people
- ○ Only one person in every 8 million people
- ○ Fewer than one person in every 10 million people

Q14 If you throw two coins, what are the chances of getting two heads?

- ○ 30%
- ○ 25%
- ○ 50%
- ○ 45%
- ○ 10%

Q15 If a poker machine returns 87% to the player and a person plays $20 through the machine, what is the typical amount they would expect to lose?

- ○ $8.70
- ○ $3.30
- ○ $2.60
- ○ $1.30
- ○ $4.50

Q16 If a deck of 52 cards is shuffled and a card is drawn. What are the chances that it is an ace?

- ○ 2 in 52
- ○ 4 in 52
- ○ 1 in 52
- ○ 4 in 26
- ○ None of the above

Numerical General Reasoning Test

Q19
Instructions

This test is designed to assess your ability to understand numbers and the relationships between numbers.

Each question has six possible answers. One and only one is correct in each case.

You now have a chance to complete the four example questions below in order to make sure that you understand the test.

Please attempt the following example questions now.

Q20 2, 4, 6, 8, 10, 12… What number comes next?

- ○ 8
- ○ 9
- ○ 11
- ○ 12
- ○ 14
- ○ 16

Q25 Which of the following is the odd one out?

- ○ 2/4
- ○ 6/8
- ○ 3/6
- ○ 4/9
- ○ 4/8
- ○ 2/6

Q26 1 is to 10 as 10 is to…?

- ○ 10
- ○ 100
- ○ 99
- ○ 98
- ○ 97
- ○ 96

Q23 There are a total of 25 questions below. Please aim to complete the test in under 10 minutes. Time is short, so when you begin the test work as quickly and as accurately as you can.

Q24 A clock gains 4 seconds every 24 hours. If it is correct at 8pm on Sunday how many seconds will it be fast at 8pm on the following Thursday?

- ○ 16
- ○ 12.5
- ○ 14
- ○ 12
- ○ 18
- ○ 16.5

Q28 ¼ is to .25 as ⅗ is to…?

- ○ .3
- ○ .6
- ○ .16
- ○ .33
- ○ .66
- ○ .06

Q29 If the original price of an item in a sale was £10.50p and this price was reduced by 20% for the sale, what is the price in the sale?

- ○ £10.10
- ○ £7.30
- ○ £9.45
- ○ £8.40
- ○ £9.40
- ○ £8.30

Q30 If there are $1.50 dollars to the pound (£), how man dollars would you get for £8?

- ○ $6
- ○ $4
- ○ $10
- ○ $10.50
- ○ $12
- ○ $12.50

Q31 8 is to 0 as 18 is to…?

- ○ 10
- ○ 12
- ○ 2
- ○ 16
- ○ 8
- ○ 6

Q32 7 is to 5 as 12 is to…?

- ○ 7
- ○ 14
- ○ 10
- ○ 13
- ○ 9
- ○ 11

Q33 If it takes 20 seconds for a machine to fill three bottles of milk, how many bottles will it fill in three minutes?

- ○ 21
- ○ 18
- ○ 27
- ○ 12
- ○ 28
- ○ 15

Q34 1.08, 2.16, 3.24, 4.32, 5.4, 6.48… What number comes next?

- 6.56
- 6.66
- 7.56
- 7.58
- 7.66
- 7.76

Q35 Which of the following is the odd one out?

- 6
- 9
- 12
- 24
- 8
- 16

Q36 1, 2, 4, 7, 11, 16,… What number comes next?

- 18
- 24
- 23
- 19
- 22
- 21

Q37 If New York is five hours behind London and Los Angeles is three hours behind New York, what time is it in Los Angeles when it is 1pm in London?

- ○ 8pm
- ○ 6pm
- ○ 8am
- ○ 9am
- ○ 10am
- ○ 5am

Q38 1.09, 1.2, 1.31, 1.42,… What number comes next?

- ○ 1.5
- ○ 1.55
- ○ 1.53
- ○ 2.53
- ○ 1.44
- ○ 1.54

Q39 If New York is five hours behind London and a plane leaves London at 12.05 (local time) and arrives at New York at 12.17 (local time), how long does the flight take in hours and minutes?

- ○ 4hr 12min
- ○ 5hr 12min
- ○ 5hr 22min
- ○ 4hr 22min
- ○ 5hr 48min
- ○ 4hr 48min

Q40 18 is to 6 as 12 is to…?

- 3
- 6
- 2
- 5
- 4
- 8

Q42 7/3 is to 1/3 as 7 is to…?

- 1/7
- 2/7
- 1
- 3/7
- ½
- 2

Q43 A train left London at 10.15pm and arrived in Aberdeen at 6.12am. How long did the journey take?

- 8hr 3min
- 7hr 3min
- 7hr 57min
- 8hr 57min
- 7hr 55min
- 6hr 55min

Q44 A car travelled at an average speed at 30km/hr for the first three hours of a four hour journey. The journey was 140km. What was the average speed for the last hour?

- ○ 50km/hr
- ○ 60km/hr
- ○ 20km/hr
- ○ 55km/hr
- ○ 70km/hr
- ○ 90km/hr

Q45 3.8, 4.88, 5.96, 7.04,… What comes next?

- ○ 8.24
- ○ 9.12
- ○ 0.04
- ○ 8.12
- ○ 8.88
- ○ 9.24

Q47 Which of the following is the odd one out?

- ○ 1.2
- ○ 2.2
- ○ 1.3
- ○ 1.8
- ○ 2.6
- ○ 1.6

Q48 3, 5, 8, 13, 21, 34,… What number comes next?

- ○ 55
- ○ 49
- ○ 47
- ○ 56
- ○ 39
- ○ 42

Q49 1.2 is to .56 as .56 is to…?

- ○ .26
- ○ .36
- ○ .28
- ○ .16
- ○ .18
- ○ .42

Q50 5000, 1000, 200, 40,… What comes next?

- ○ 5
- ○ 25
- ○ 7
- ○ 35
- ○ 8
- ○ 9

Q51 13 is to 169 as 11 is to…?

- 122
- 121
- 212
- 112
- 111
- 221

Q52 There is £32.34 in petty cash. The secretary need to buy three bottles of correcting fluid at 30p each, and a new note pad at 42p, how much cash will there be left?

- £31.30
- £31.32
- £30.92
- £32.02
- £31.02
- £31.12

Q53 2, 2, 2, 2, 4, 4, 4, 8, 8,… What comes next?

- 8
- 7
- 16
- 15
- 32
- 9

Cognitive Reflection Test

Q54 A bat and a ball cost $1.10 in total. The bat costs $1.00 more than the ball. How much does the ball cost?

_____

Q55 If it takes 5 machines 5 minutes to make 5 widgets, how long would it take 100 machines to make 100 widgets?

_____

Q56 In a lake, there is a patch of lily pads. Every day, the patch doubles in size. If it takes 48 days for the patch to cover the entire lake, how long would it take for the patch to cover half of the lake?

Q57
Thank you for participating in this study.

Your participation is greatly appreciated. If participation in this study has caused any concern for you, please call the Gambling Helpline on **1800 858 858** or visit Gambling Help Online.

For PsychMed Participants:

Thank you for participating in this study.

Your participation is greatly appreciated. Please enter an email address below to receive a $20 Myer e-Gift Card for your time and effort. If you would like to receive a copy of the final report for this study, please provide an email address in the second text box below. Your email address will not be used for any other purposes.

If participation in this study has caused any concern for you, please call the Gambling Helpline on 1800 858 858 or visit Gambling Help Online. Free, confidential and professional counselling and therapy for individuals, couples, family and friends is available at one of the many Gambling Help Services across the State, please call 1800 858 858. Further help is available free of charge at the SA Intensive Gambling Help Service (SAIGHS) provided by PsychMed for gamblers and those affected by gambling, please call 8232 3333 or visit PsychMed's website.

Any questions about the project may be directed to Prof Paul Delfabbro (08 83134936 or paul.delfabbro@adelaide.edu.au) or Elizabeth McCarron (elizabeth.mccarron@student.adelaide.edu.au).

49 A $20 Myer e-Gift Card will be sent to the email address you provide below:

50 If you would like to receive a copy of the final report for this study, please provide an email address below:

Appendix B: Email & Letter Invitation to Participants - PsychMed

Email
Subject Line: Invitation to participate in an online research study with the University of Adelaide.

Dear client,

You are being invited to participate in a research project conducted by Elizabeth McCarron, Practice Manager at PsychMed Payneham. This research will form the basis for the degree of Bachelor of Psychological Science (Honours) at the University of Adelaide under the supervision of Professor Paul Delfabbro. This research will be conducted in collaboration with PsychMed Pty Ltd.

This research project aims to explore the beliefs that gamblers have about gambling and whether these differ depending on the style of gambling they engage in. For example, how do people understand probability, skill, chance and the meaning of events that occur in gambling.

You are being invited as you have previously engaged or are currently engaging in the South Australian Intensive Gambling Help Service at PsychMed.

You are invited to participate in an online survey containing a number of measures relating to gambling. The survey will ask questions about your thoughts on gambling as well as some mathematical odds and reasoning questions.

The survey will take approximately 20-30 minutes to complete and you will receive a **$20 Myer E-Gift Card** as compensation for your time and effort.

To participate in this study, please click the link below and you will be redirected to more information before beginning the survey.

https://www.surveymonkey.com/r/9CQCYMS

[redacted]

Kind regards,

Elizabeth McCarron
[redacted]

Posted Letter

11th July 2018

Dear ******,

You are being invited to participate in a research project conducted by Elizabeth McCarron, Practice Manager at PsychMed Payneham. This research will form the basis for the degree of Bachelor of Psychological Science (Honours) at the University of Adelaide under the supervision of Professor Paul Delfabbro. This research will be conducted in collaboration with PsychMed Pty Ltd.

This research project aims to explore the beliefs that gamblers have about gambling and whether these differ depending on the style of gambling they engage in. For example, how do people understand probability, skill, chance and the meaning of events that occur in gambling.

You are being invited as you have previously engaged or are currently engaging in the South Australian Intensive Gambling Help Service at PsychMed.

You are invited to participate in an online survey containing a number of measures relating to gambling. The survey will ask questions about your thoughts on gambling as well as some mathematical odds and reasoning questions.

The survey will take approximately 20-30 minutes to complete and you will receive a **$20 Myer E-Gift Card** as compensation for your time and effort.

To participate in this study, please type the following URL into a web browser:

https://www.surveymonkey.com/r/9CHZMXR

This link will direct you to more information about the study before beginning the survey.

Alternatively, please email elizabeth.mccarron@student.adelaide.edu.au or call Elizabeth on 0414 188 360 to have a direct link sent to your email address.

Any questions about the project may be directed to Prof Paul Delfabbro (08 83134936 or paul.delfabbro@adelaide.edu.au) or Elizabeth McCarron (elizabeth.mccarron@student.adelaide.edu.au).

Kind regards,

Elizabeth McCarron
Practice Manager, PsychMed Payneham
B. Arts (Psychology) B. Laws
B. Psychological Science (Hons) cont.

Appendix C: Participant Information Sheet

PARTICIPANT INFORMATION SHEET

PROJECT TITLE: Gambling beliefs in skilled and chance-based gambling

HUMAN RESEARCH ETHICS COMMITTEE APPROVAL NUMBER: [redacted]

PRINCIPAL INVESTIGATOR: Professor Paul Delfabbro
STUDENT RESEARCHER: Elizabeth McCarron
STUDENT'S DEGREE: Bachelor of Psychological Science (Honours)

Dear Participant,

You are invited to participate in the research project described below.

What is the project about?

This research project aims to explore the beliefs that gamblers have about gambling and whether these differ depending on the style of gambling they engage in. For example, how do people understand probability, skill, chance and the meaning of events that occur in gambling.

Who is undertaking the project?

This project is being conducted by Elizabeth McCarron. This research will form the basis for the degree of Bachelor of Psychological Science (Honours) at the University of Adelaide under the supervision of Professor Paul Delfabbro. This research will be conducted in collaboration with PsychMed Pty Ltd.

Why am I being invited to participate?

(For PsychMed Participants): You are being invited as you have previously engaged or are currently engaging in the South Australian Intensive Gambling Help Service at PsychMed.

(For Qualtics participants): You are being invited as you identify as having some regular (at least fortnightly) experience gambling on activities that might involve skill or chance.

What am I being invited to do?

You are being invited to participate in an online survey containing a number of measures relating to gambling. The survey will ask questions about your thoughts on gambling as well as some mathematical odds and reasoning questions.

(For PsychMed Participants): You will receive a $20 Coles-Myer gift card as compensation for your time and effort.

How much time will my involvement in the project take?

The online survey will take approximately 15 minutes to complete.

Are there any risks associated with participating in this project?

The survey will ask some questions relating to gambling habits and behaviour. If participation in this study causes any concern for you, please call the Gambling Helpline on **1800 858 858** or visit Gambling Help Online. Free, confidential and professional counselling and therapy for individuals, couples, family and friends is available at one of the many Gambling Help Services across the State, please call **1800 858 858.** Further help is available free of charge at the SA

Intensive Gambling Help Service (SAIGHS) provided by PsychMed for gamblers and those affected by gambling, please call **8232 3333** or visit PsychMed's website.

What are the potential benefits of the research project?

Your participation in this project may contribute to our understanding on the effect that gambling style has on gambling cognitions. It may also contribute to the body of research concerning effective therapy techniques for gambling. Please be aware there may be no immediate benefits to you if you participate in this study.

Can I withdraw from the project?

Participation in this project is completely voluntary. If you agree to participate, you can withdraw from the study at any time up until the submission of the survey.

What will happen to my information?

Your privacy and confidentiality will be protected in your participation in this study. Your personal information will be removed and replaced with a code. With your consent, we may access your results on a previous assessment conducted at PsychMed. This measures is the Problem Gambling Severity Index.

Data from this data will be kept anonymously in a secure storage room for 5 years, but none of it will be individually identifiable.

The information gained from this project will be published in a University Honours Degree thesis. You will not be identified in this publication and only summary data will be published. If you would like to receive a copy of the final report, please provide an email address in the final question of this survey.

Your information will only be used as described in this participant information sheet and it will only be disclosed according to the consent provided, except as required by law.

Who do I contact if I have questions about the project?

Any questions about the project may be directed to Prof Paul Delfabbro (08 83134936 or paul.delfabbro@adelaide.edu.au) or Elizabeth McCarron (elizabeth.mccarron@student.adelaide.edu.au).

For any questions about the ethical conduct of the research, please contact Dr. Diana Dorstyn, Acting Chair of the Human Research Subcommittee in the School of Psychology (Diana.Dorstyn@adelaide.edu.au).

If I want to participate, what do I do?

To participate in this study, please read the consent form on the next page and click accept if you agree to the terms. It is recommended that you keep a copy of this Information Page.

Yours sincerely,

Elizabeth McCarron
B. Arts (Psychology) B. Laws
B. Psychological Science (Hons) cont.

Prof Paul Delfabbro
PhD., B.A. (Hons), B.Ec.

Appendix D: Consent Form

Human Research Ethics Committee (HREC)

THE UNIVERSITY of ADELAIDE

CONSENT FORM

1. I have read the attached Information Sheet and agree to take part in the following research project:

Title:	**Gambling beliefs in skilled and chance-based gambling**
Ethics Approval Number:	[redacted]

2. I have had the project, so far as it affects me, and the potential risks and burdens fully explained to my satisfaction by the research worker. I have had the opportunity to ask any questions I may have about the project and my participation. My consent is given freely.

3. Although I understand the purpose of the research project, it has also been explained that my involvement may not be of any benefit to me.

4. I agree to participate in the activities outlined in the participant information sheet.

5. I understand that I am free to withdraw from the project at any time up until the submission of the survey.

6. I have been informed that the information gained in the project will be published in a University Honours Degree thesis.

7. I have been informed that in the published materials I will not be identified and my personal results will not be divulged.

8. My information will only be used for the purpose of this research project and it will only be disclosed according to the consent provided, except where disclosure is required by law.

9. I am aware that I should keep a copy of both the Information Page and this Consent Form.

If you consent these terms, please tick the box below and proceed to the survey.

- ❑ I consent to the above terms.